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Developing an Instrument to Measure Socioeconomic Disparities in Quality of Care for
Men with Early-Stage Prostate Cancer

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14. ABSTRACT

Patients with early stage prostate cancer have excellent cause specific survival after definitive local therapy with radiation therapy or radical prostatectomy. However, regardless of race, men of lower socioeconomic status are less likely to receive definitive local therapy for early stage disease, and when such treatment is administered, they are more likely to die of their cancer. Men of lower socioeconomic status are also more likely to have treatment related complications after prostate cancer treatment. This suggests that disparities in treatment, rather than prostate cancer screening, may play a causative role in observed differences.
• Hypothesis: Socioeconomic disparities in prostate cancer survival are associated with distinct differences in quality of care. These distinct patterns can be identified and measured using standard medical diagnosis and treatment codes.
• Specific Aims:
    1. To identify socioeconomic disparities in outcomes after treatment for localized prostate cancer.
    2. To identify socioeconomic disparities in quality of care for localized prostate cancer.
    3. To develop a tool to measure disparities in quality of care for localized prostate cancer.

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INTRODUCTION:

Patients with early stage prostate cancer have excellent cause specific survival after definitive local therapy with radiation therapy or radical prostatectomy. However, regardless of race, men of lower socioeconomic status are less likely to receive definitive local therapy for early stage disease, and when such treatment is administered, they are more likely to die of their cancer. Men of lower socioeconomic status are also more likely to have treatment related complications after prostate cancer treatment. This suggests that disparities in treatment, rather than prostate cancer screening, may play a causative role in observed differences. We hypothesize that socioeconomic disparities in prostate cancer survival are associated with distinct differences in quality of care that can be identified and measured using standard medical diagnosis and treatment codes. Therefore, the aims our work was to

Specific Aims:
1. To identify socioeconomic disparities in outcomes after treatment for localized prostate cancer.
2. To identify patterns in quality of care for men with for localized prostate cancer according to socioeconomic status.
3. To characterize socioeconomic disparities in quality of care for localized prostate cancer.

BODY:

In this section of the report, I am to describe the research accomplishments associated with each task outlined in the approved Statement of Work. I have copied my approved statement of work and specific aims below.

STATEMENT OF WORK

Phase I: Institutional and SEER clearance.
       Months 0-6
       Outcome: Approval for the study. Obtain data for the study.
              Task 1. Obtain Institutional Review Board (IRB) Approvals (Months 0-6).
              Task 2. Obtain data from SEER Medicare databases. Submit 10 page online proposal to the SEER Medicare program. The approval process takes approximately 6 weeks. Once approved, we can then purchase SEER Medicare linked data.

Phase II: Data organization and cleaning.
       Months 6-20
       Outcome: Data suitable for statistical analysis
              Task 1. Programming to develop variables of interest from billing codes.
              Task 2. Evaluate variables of interest. Check for internal consistency. Exclude invalid fields where appropriate.

***Transition from UC Davis to OHSU
       Months 20-24
       Outcomes: Successful move of data from UCD to OHSU
              Task 1: Notify biostats and programming support at UCD of plans to move. Notify UCD IRB of plans to close study. Notify the SEER registry of plans to move data.
              Task 2: Re apply for SEER data: The SEER registry strictly enforces their data protection protocol, thus no SEER data is to move from institution to institution. Programming codes can move institutions, however. A completely new application will be submitted. I anticipate this will take 4 months. Previous programming code can then be applied.

Phase III: Data analysis and presentation
    Months 24-40
    Outcome: Results suitable for publication/presentation.
        Task 1. The association between socioeconomic status and disease specific outcome measures will be evaluated using Cox proportional hazard models and Kaplan Meier analyses for overall and disease specific survival. A multivariate regression analysis will be performed controlling for age and comorbidity.
        Task 2. To evaluate the association between socioeconomic status and treatment specific outcome measures using logistic regression analysis.

As stated in Phase I, we have obtained IRB approvals as well as access to the SEER Medicare linked dataset. The IRB approval process took approximately 3 months. We sought access to SEER Medicare linked data concurrently. This took over 6 months to achieve due to staffing shortages at the NCI, and we have recently received the data. During this interval we also sought appropriate statistical support. With the help of grant funds, we are providing partial salary support to a recent PhD from our department of biostatistics and epidemiology, Clayton Schupp. On a personal note, I was on maternity leave from May to September, and had sought DOD approval for leave during this period.

As for Phase II of our statement of work, our first look at the dataset demonstrated that there would be a significant amount of work required to evaluate and clean the dataset for analysis. There are many cases for which variables were unknown that needed to be explored within the SEER dataset. In addition, significant programming was required to score comorbidities, evaluate socioeconomic status from census and zip code data, and organize PSA (prostate specific antigen) data for potential use. Much of this work was done with Yolanda Hagar in the department of statistics at UC Davis, as Clayton Schupp took a position in the San Francisco Bay Area.

We then began the process of linking to the Medicare dataset, where billable clinical activities around the time of diagnosis and treatment could be assessed. Using billing codes and coding tables that we have defined previously (Appendix ii, Appendix iii), we began our analysis. The outcome measure we investigated was urinary side effects of prostate cancer treatment.

       Phase III comprised the bulk of our analysis, which continued throughout the course of our funding period.

Specific Aim 1. <u>To identify socioeconomic disparities in outcomes after treatment for localized prostate cancer.</u>

The Impact of SES on outcomes after RP in California

Prostate cancer has the largest range in survival between races of any cancer type, with approximately 13% increased risk of prostate cancer mortality among African Americans when compared to Caucasians. (1, 2) There are numerous hypotheses to explain this observation, including biological causes, patient beliefs, and physician biases. However, socioeconomic status, which is often linked to race, has not been well investigated. In the first aim of our grant, we sought to investigate the impact of socioeconomic status (SES) and disease specific survival.

To do this, we initially used the California Cancer Registry. This database is a prospective cancer registry maintained by the California Department of Health Services that captured cancer patients in the state of California from 1988-2005. The measure of SES was that used by Yost et al (3). Bivariate analyses were conducted to examine the relationships between: (1) SES and radiation therapy and (2) SES and radical prostatectomy, stratified by the following variables: year of diagnosis, race, and age group. For the survival analyses, our outcome of interest was death resulting from prostate cancer which was categorized according to the International Classification of Diseases system. Cases with ICD-9 cause of death code 185 and those with ICD-10 cause of death code C61 were designated as having died of prostate cancer. Between January 1996 and December 2005, we identified 39,234 patients who underwent radical prostatectomy (RP) and 42,431 men who underwent external beam radiation as initial therapy for clinically localized, Gleason 7 or less prostate cancer.   Unadjusted survival curves by SES were produced using the Kaplan-Meier method. Cox proportional hazards models were generated to examine the effect of SES on survival from prostate cancer. Two separate models were produced, one for patients who received radiation therapy and another for those who underwent radical prostatectomy. The models were adjusted for age and race/ethnicity.

Five-hundred seventy-three men (0.5%) died of prostate cancer in the radiation group, and 210 patients (0.2%) died of prostate cancer in the RP group. When analyzed according to SES, we found that men of lower SES who underwent RP had a higher odds of cancer-specific death over the time frame studied, with men of lower SES being 2 times more likely to die of prostate cancer than men of higher SES. (95% CI 1.28-3.09, P = 0.002) (Table 1)

Quintile of SES	Percent of Patients	Unadjusted HR (95% CI)	P Value
SES Quintile 1	9.7	1.99 (1.28-3.09)	0.002
SES Quintile 2	15	1.53(1.01-2.31)	0.042
SES Quintile 3	19.3	1.49(1.01-2.19)	0.045
SES Quintile 4	23.5	0.94 (0.62-1.42)	0.757
SES Quintile 5	32.5	Reference 1.0	

Table 1. Cox proportional hazards model controlling for age and race demonstrating prostate cancer specific survival in patients undergoing radical prostatectomy.

Interestingly, when adjusted for race, these differences were even more disparate, as patients in the lower SES were 2.2 more likely to die of prostate cancer that in the highest SES (95% CI 1.38-3.5, p=0.001). (Table 2)

| Quintile of SES	Percent of Patients	Race * and age Adjusted HR (95% CI)	P Value
SES Quintile 1	9.7	2.20 (1.38-3.50)	0.001
SES Quintile 2	15	1.57 (1.04-2.39)	0.034
SES Quintile 3	19.3	1.49 (1.01-2.20)	0.045
SES Quintile 4	23.5	0.93 (0.61-1.41)	7.32
SES Quintile 5	32.5	Reference 1.0	

Table 2. Prostate cancer specific survival in patients undergoing radical prostatectomy adjusted for race.

In the case of radiation therapy, men of the lowest SES were 2.24 times more likely to die of prostate cancer than those in the highest SES (95% CI 1.71-2.94, P _.001) and when adjusted for race, those of the lowest SES were 2.21 times more likely to die of prostate cancer (95% CI 1.66-2.95, P _.001). Table 3

Quintile of SES	Unadjusted HR (95% CI)	P Value	Race * and age Adjusted HR (95% CI)	P Value
SES Quintile 1	2.24(1.71-2.94)	<.001	2.21 (1.66-2.95)	<.001
SES Quintile 2	1.57(1.22-2.04)	<.001	1.50 (1.15-1.96)	0.003
SES Quintile 3	1.60(1.26-2.03)	<.001	1.55 (1.22 -1.97)	<.001
SES Quintile 4	1.13 (0.88-1.45)	0.335	1.12 (0.87-1.44)	0.371
SES Quintile 5	Reference 1.0		Reference 1.0	

Table 3. Prostate cancer specific survival in patients undergoing external beam radiation therapy with and without adjustment for race.

Kaplan Meier analysis confirmed the association between SES and cancer specific survival after radical prostatectomy and external beam radiation therapy. (Figures 1 and 2)
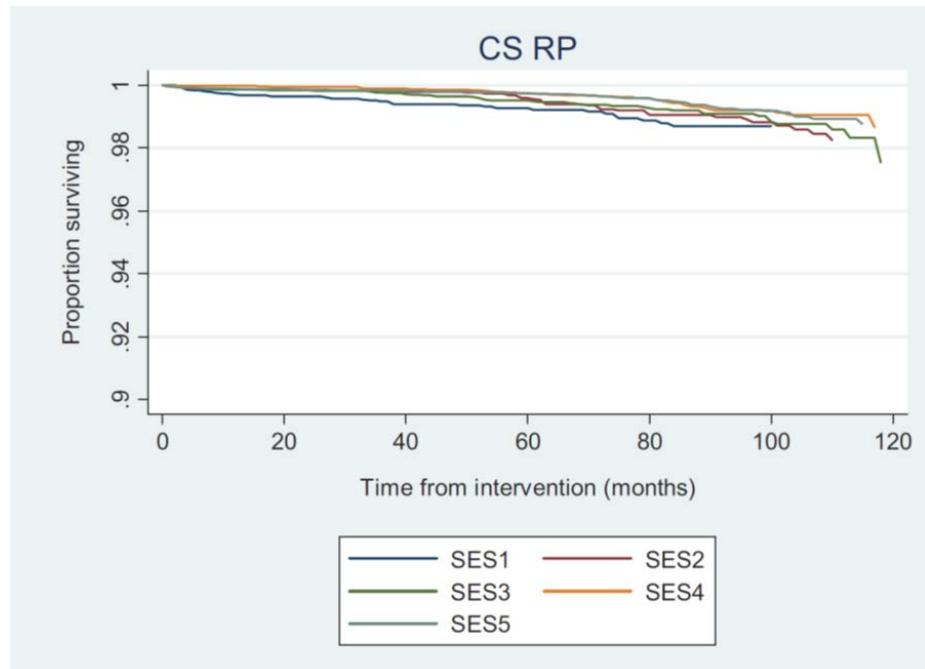
Figure 1 Kaplan Meier analysis demonstrating cancer specific survival for patients undergoing radical prostatectomy for low risk prostate cancer.
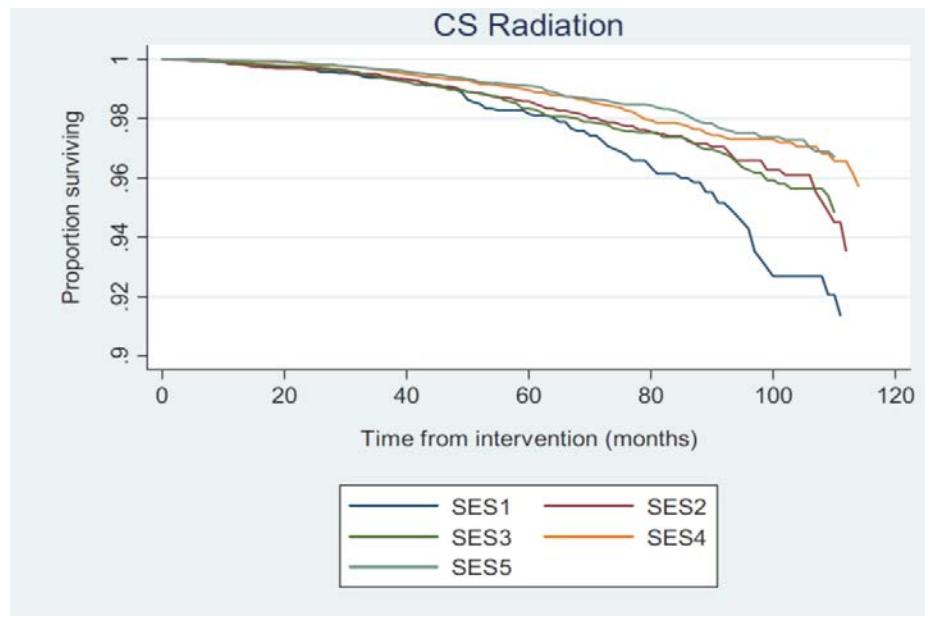
Figure 2 Kaplan Meier analysis demonstrating cancer specific survival for patients undergoing external beam radiation for low risk prostate cancer.

The Impact of SES on cancer specific outcomes after RP on a National Level

We then sought to validate these findings at a national level. To do this, we used the SEER (Surveillance, Epidemiology, and End Results) database, a prospective national cancer registry that captured data on approximately 26% of the American population during 1973 to 2005. (4)

Clinical Cohort: Our initial study cohort consisted of 177,668 men with prostate cancer, diagnosed from 2000 to 2008. The clinical features of our patient population are demonstrated in Table 4. Most men were in the 65-69 year old range (40%), and there were fewer men over 80 within the cohort (9%). The majority of patients were Caucasian (80%). The majority of patients were married (75%). Most patients (60%) had grade 6 and 7 disease.

Clinical Feature	n	%	Clinical Feature	n	%
Age			**Grade**		
65-69	52456	29.5%	G1	4809	2.7%
70-74	50680	28.5%	G2	106243	59.8%
75-79	40214	22.6%	G3	54591	30.7%
80-84	22039	12.4%	G4	575	0.3%
85+	12279	6.9%	Unknown	11450	6.4%
Race			**Stage**		
White	142814	80.4%	T1	1300	0.7%
Black	19251	10.8%	T2	10929	6.2%
Asian	6137	3.5%	T3	5004	2.8%
Hispanic	4482	2.5%	T4	9097	5.1%
Native American	374	0.2%	Unknown	151338	85.2%
Other	4610	2.6%			
Marital Status					
Single	12145	6.8%			
Married	120442	67.8%			
Separated	1014	0.6%			
Divorced	8460	4.8%			
Widowed	16162	9.1%			
Unknown	19445	10.9%			

Table 4. Clinical characteristics of 177,668 patients with prostate cancer identified from the SEER dataset from 2000-2008.

Definition of Socioeconomic status: There are various ways of measuring SES. Type of insurance can reflect family employment and income levels, but is only an estimation. Patient level income data is the most direct way of measuring socioeconomic status, but it is prone to reverse causality biases. For example, if a patient had poor quality of care and was of lower income, did the lower income cause the poor quality, or did the poor quality result in decreased income? Education level is another excellent method of determining SES, particularly on the individual level, because it is not prone to such biases. But with improved access to education for

all SES levels, may not directly reflect income. Furthermore, there is not always a direct connection between education and income.

Numerous studies have utilized these methods for determining SES. (5, 6, 7,8) Franks et al used an individual based measure of income less than 150% of the poverty level, or less than 12 years of schooling to measure the impact of SES on coronary heart disease with successful results. Fenton et al used US Department of Agriculture Rural/Urban codes and zip code level median income to evaluate the impact of race and colorectal cancer testing. To determine the impact of SES on cervical cancer incidence and survival, Singh et al used both income and education using county/census tract proportion of subjects below the poverty line and proportion of subjects with at least a high school diploma. For the purposes of this study, we followed the Singh model of SES measurement, by including both income and education.

The socio-economic status of each individual was based on census data; specifically, we examined the percentage of people in each subjects census zone who finished high school, and the median income of each subjects census zone. The measures were then broken down into quartiles.

Definition of SES quartiles:

Median income

   Q1 = $35,961

   Q2 = $48,084

   Q3 = $65,204

Percent finished high school

   Q1 = 18.3%

   Q2 = 25.2%

   Q3 = 32.38%

Results: Both income (Figure 3) and education (Figure 4) had a significant impact on disease specific survival after prostate cancer treatment, with patients with lower median income and less education having worse prostate cancer survival.
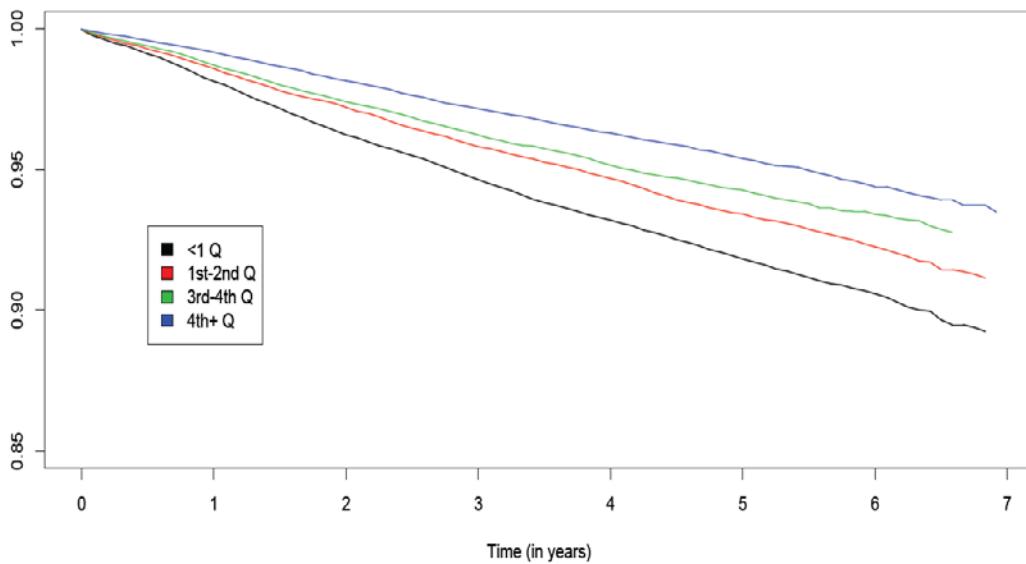
Figure 3. Kaplan Meier analysis demonstrating prostate cancer survival as stratified by SES, when SES is defined by quartiles of **_median income._**
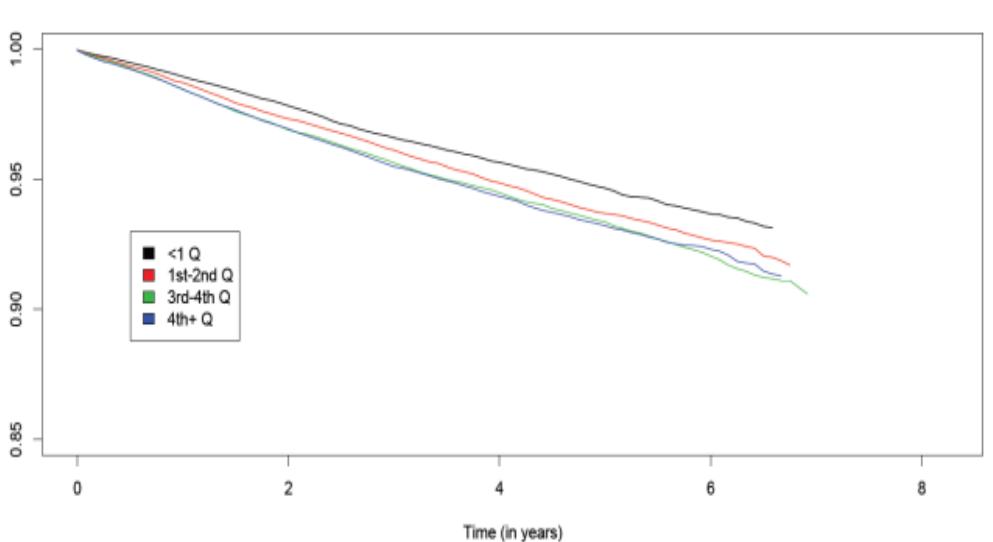
Figure 4. Kaplan Meier analysis demonstrating prostate cancer survival as stratified by SES, when SES is defined by **_level of education._**

Specific Aim 2. To identify patterns in quality of care for men with for localized prostate cancer according to socioeconomic status.

Our goal in this aim was to demonstrate variations in the quality of primary treatment for prostate cancer.

Quality of care endpoint: Urinary incontinence is a common and troubling side effect after prostate cancer treatment, in which patients involuntarily leak urine during periods of abdominal pressure or straining (Stress incontinence). While there are various endpoints which could reflect quality of primary treatment, we felt that post-treatment urinary continence would an excellent surrogate endpoint for quality of care in our study for a number of reasons. First, urinary continence and urinary side effects are exquisitely sensitive to subtle differences in the quality of primary treatment technique (radiation, surgery). Second, urinary incontinence is an important endpoint to measure, as it has a significant impact on overall patient satisfaction and post treatment quality of life. Third, because of the impact of urinary continence on quality of life, patients are far more likely to report their symptoms to their doctor and are more likely to seek treatment compared to other endpoints such as erectile dysfunction. Fourth, continence related events occur early after prostate cancer treatment and can be measured using diagnosis and billing codes in the SEER medicare linked dataset.

Measuring continence:

To measure continence using our original dataset from the SEER Medicare database, we used both diagnosis codes for urinary incontinence and billing codes for continence related procedures. Using these measures, we found that the most frequent diagnosis codes used were incontinence of urine, urge incontinence, and stress incontinence (male). (Table 5)

Continence diagnosis	ICD-9 Code	Number of cases coded in Medicare
Intrinsic Sphincter Deficiency	599.82	1617
Incontinence of urine	788.3	21878
Urge incontinence	788.31	20354
Stress incontinence, male	788.32	27928
Mixed incontinence, male or female	788.33	6489
Incontinence w/o sensory awareness	788.34	1177

Table 5. Continence diagnoses codes and distribution in the SEER medicare dataset.

New Work

Using our initial cohort described in Table 4, we evaluated the association between stress urinary incontinence and SES as determined by median income. Stress incontinence was diagnosed in 8339/39,972 patients in the first quartile of median income, 7203/38,531 in the second quartile of median income, 6967 of 40,300 patients in the third quartile, and 7036/41,897 patients in the fourth quartile, demonstrating a direct association between SES and incontinence after prostate cancer treatment, where patients with higher SES are less likely to have urinary incontinence after treatment. (Figure 5)
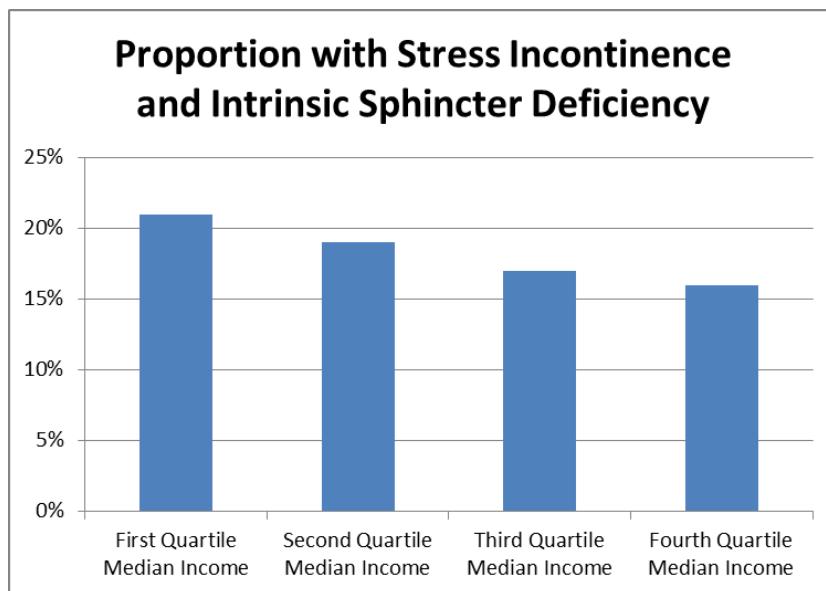
Figure 5. Higher rates of urinary incontinence are directly related to lower median income.

Similarly, when evaluated by proportion completing high school, 8900/45108 patients in the lower quartile of completing high school, 8319/41907 patients in the second quartile of completing high school, 5707/36391 patients in the third quartile of completing high school, and 6619/37294 patients in the fourth quartile of completing high school noted stress urinary incontinence after prostate. (Figure 6)
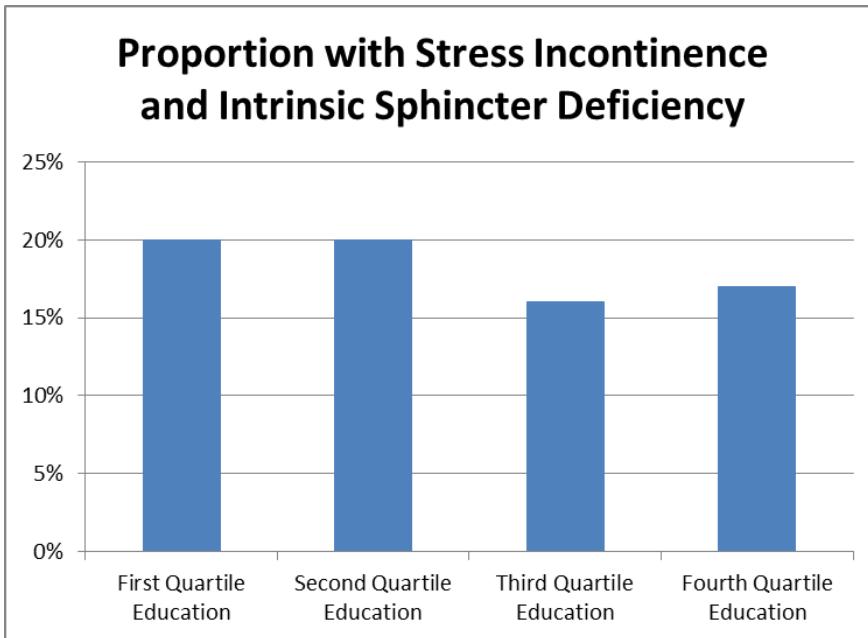
Figure 6. Higher rates of urinary incontinence are directly related to lower education level.

Multivariable analysis demonstrated several important findings. Age, Race, Median Income, Race, Education, and T Stage all had an independent impact on the likelihood of having a diagnosis/treatment of urinary incontinence. (Table 7) Kaplan Meier analysis (Figs 7-11) demonstrate the known impact of treatment type and age on the time to a urinary event, as well as the impact of race, treatment, income, and education on continence. On Kaplan Meier analysis, age, race, and treatment type were strongly associated with continence after prostate cancer treatment. Lower education level had little effect, and median income demonstrated a small, but measurable difference in time to incontinence.
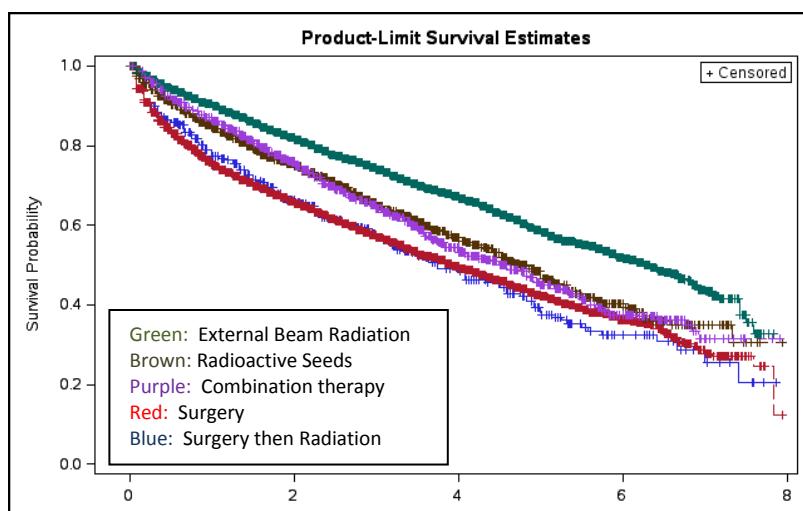
Figure 7. Kaplan Meier Curve demonstrating time to urinary symptom/treatment event according to treatment.

| | Radical Prostatectomy | | | | External Beam Radiation | | | |
| | | 95% CI | | p | | 95% CI | | p |
	OR	LB	UB		OR	LB	UB	
Race								
Caucasian		Baseline				Baseline		
Black	0.99	0.86	1.14		1.33	1.15	1.54	
Other/ unknown	0.82	0.67	1.01	<0.01	0.79	0.6	1.05	<0.01
Asian	1.16	0.93	1.45		1.06	0.83	1.34	
Hispanic	1.51	1.18	1.94		1.3	0.98	1.72	
Age								
75-85 yrs		Baseline				Baseline		
75 yrs or younger	0.74	0.66	0.83	<0.01	0.68	0.62	0.76	<0.01
older than 85 yrs	0.99	0.79	1.25		2.19	1.43	3.37	
Median Income								
Below the first quartile		Baseline				Baseline		
Between 1st and 2nd quartiles	0.93	0.83	1.04		0.87	0.75	1	
Between 2nd and 3rd quartiles	0.85	0.75	0.95	0.05	0.91	0.79	1.05	0.21
Above 3rd quartile	0.91	0.8	1.04		0.89	0.76	1.04	
Education								
Below the first quartile		Baseline				Baseline		
Between 1st and 2nd quartiles	1.01	0.9	1.13		0.91	0.78	1.05	
Between 2nd and 3rd quartiles	1.13	1	1.27	0.16	0.99	0.85	1.16	<0.01
Above 3rd quartile	1.07	0.94	1.22		1.21	1.03	1.42	
Lymph node status								
No Cancer		Baseline				Baseline		
Cancer	1.03	0.73	1.44	0.87	1.22	0.58	2.56	0.61
T Stage								
T3/T4		Baseline				Baseline		
T0 or T1	0.71	0.61	0.81	<0.01	0.85	0.66	1.1	0.34
T2	0.92	0.81	1.04		0.89	0.69	1.15	

Table 6. Multivariable model showing the impact of median income and education on continence after radical prostatectomy and radiation therapy.
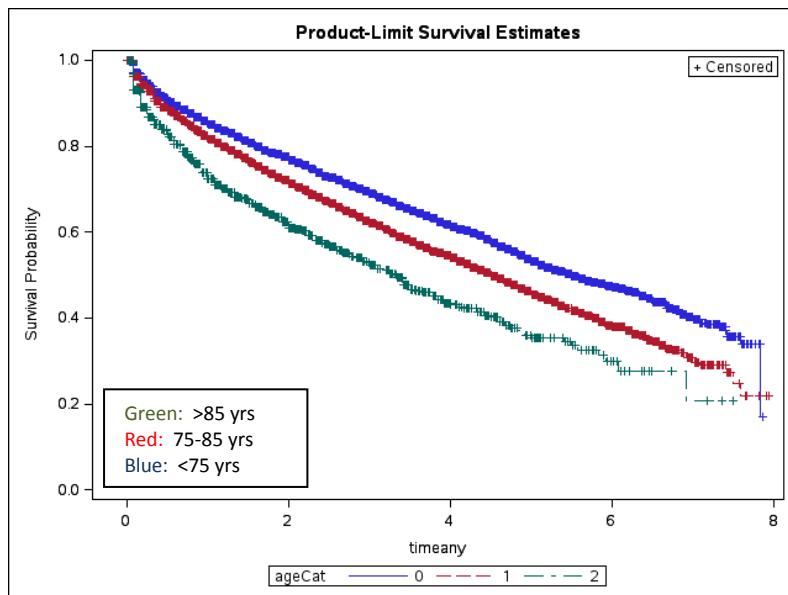
Figure 8. Kaplan Meier Curve demonstrating time to urinary symptom/treatment event according to age.
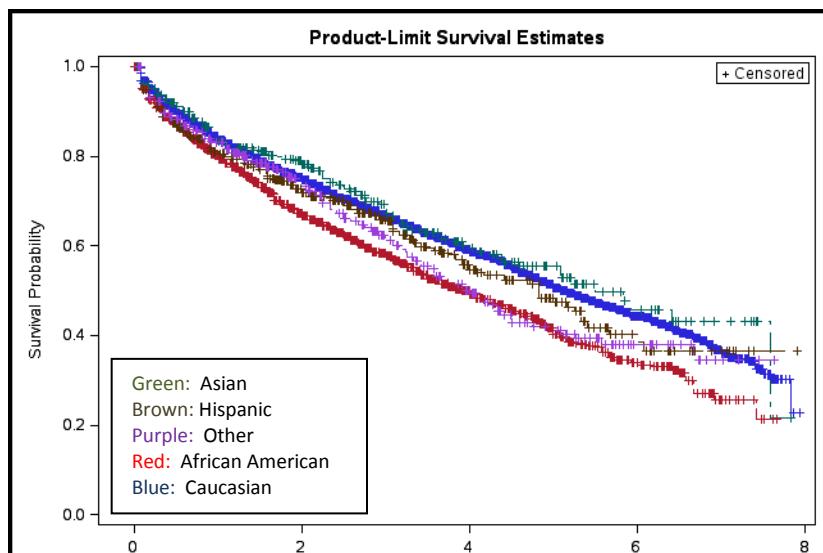
Figure 9. Kaplan Meier analysis demonstrating time to urinary symptom/treatment event according to race.
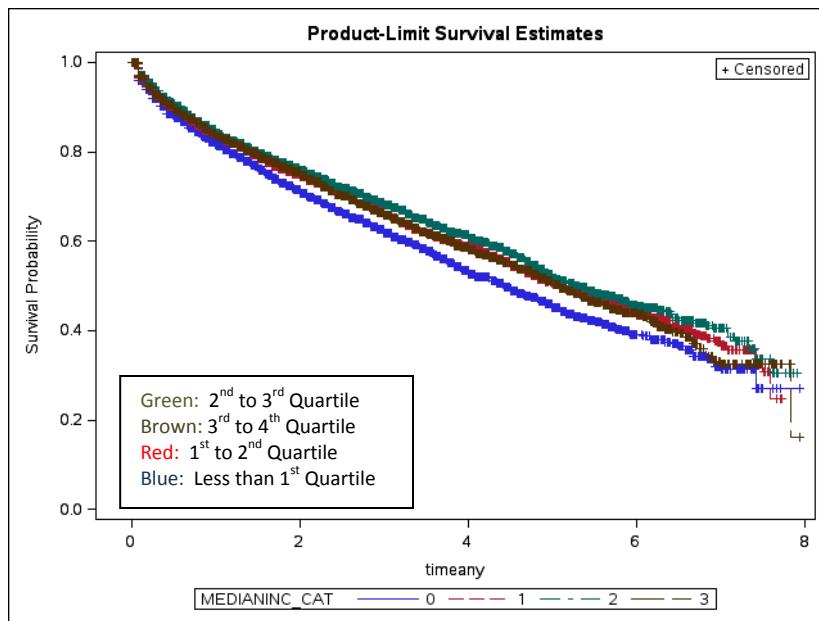
Figure 10. Kaplan Meier analysis demonstrating time to urinary symptom/treatment event according to income.
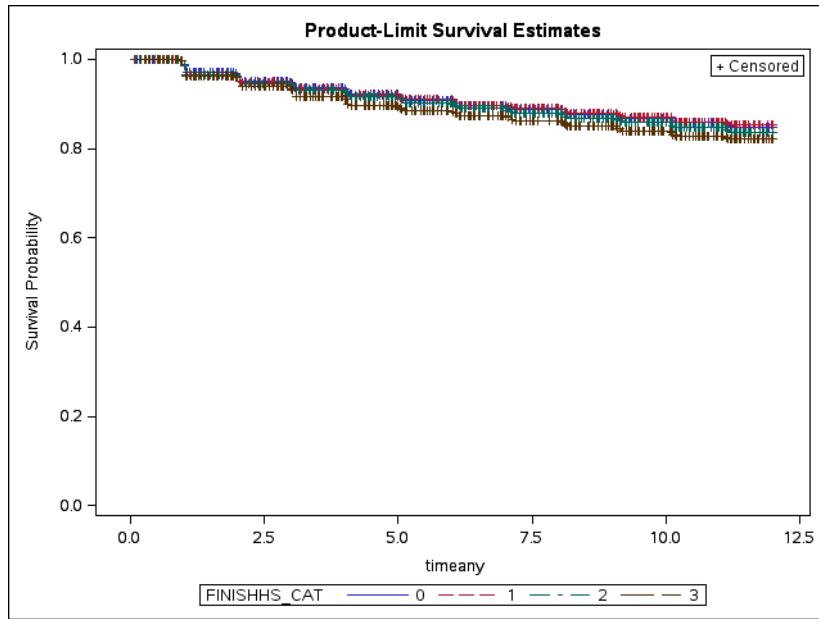
Figure 11. Kaplan Meier analysis demonstrating time to urinary symptom/treatment event according to income.

Study cohort: To further evaluate the endpoint of quality of care, we restricted our analysis to a cohort of patient who met the following criteria. This brought us to a population of 101,015 patients:

| Inclusion Criteria |
| :---: |
| Age 65 or older at diagnosis |
| No previous cancer diagnoses |
| Clinically confirmed localized cancer, with no evidence of metastasis |
| Primary treatment with surgery or radiation only (or combination) |
| No variant or undifferentiated histologies |

Findings: Of the 101,015 patients identified, 11526 (11.4%) men had a diagnosis of urinary incontinence. Of these, 272 (2.4%) underwent treatment with a sling procedure, 265 (2.3%) underwent treatment with injection of a bulking agent, and 294 (2.6%) underwent treatment with an artificial urinary sphincter for management of their incontinence. Interestingly, despite high levels of urinary incontinence after treatment, most patients do not undergo treatment for incontinence. (Table 7)

Treatment for urinary incontinence	Number Incontinent	Number (proportion) of incontinent patients treated		
		Sling (n)	Injection	Artificial sphincter
Radical prostatectomy	6637	257 (3.87%)	247 (3.72%)	261 (3.93%)
External beam radiation	2258	4 (0.17%)	3 (0.13%)	9 (0.4%)
Brachytherapy	1362	0	3 (0.22%)	5 (0.37%)
Other	1269	11 (0.8%)	12 (0.9%)	19 (1.5%)

Table 7. Despite having urinary incontinence, most patients do not undergo treatment for incontinence after prostate cancer treatment.

Specific Aim 3. To characterize socioeconomic disparities in quality of care for localized prostate cancer.

Developing a Cox Proportional Hazards Model for Time to Incontinence after prostate cancer treatment.

To investigate the effects of socio-economic status on the time to an incontinence diagnosis after treatment, we used Cox proportional hazards models. This type of model allows us to quantify how socio-economic status and other covariates may decrease or increase the time to an incontinence diagnosis, while accounting for censoring. Subjects had an observed incontinence diagnosis or treatment (i.e. were "uncensored") if a diagnosis of incontinence was given post-treatment for prostate cancer within the study window (2000-2008) or before death. Otherwise, subjects were considered censored. In addition to SES, we accounted for age, race, tumor grade, year of treatment, and type of treatment. We first considered the simple Cox proportional hazards model only including the SES high school and SES income as categorical variables, and then added the other covariates individually. Subsequently, we created multivariate Cox proportional hazards models based on the results of the smaller models.

Table 8 shows the Cox proportional hazard model results for the full models. Two models are shown, one which includes race a covariate, and one that does not. This was done in order to examine if race was collinear with either or both of the SES variables – if the SES parameter estimates or p-values changed dramatically, this would hint that race was collinear with these covariates. However, this was not the case, and it appears that the full model that includes race is appropriate.

Clinical and Demographic Characteristics	Percent change		
	Est	95% CI	P value
Median Income	1	Baseline	
Q0-Q1	0.94	(0.9, 0.98)	0.0067
Q1-Q2	0.90	(0.86, 0.95)	<0.01
Q2-Q3	0.90	(0.86, 0.95)	<0.01
Q3-Q4	0.96	(0.91, 1)	0.07
Percent completed HS			
Q0-Q1	1	Baseline	
Q1-Q2	0.96	(0.91, 1)	0.07
Q2-Q3	0.99	(0.94, 1.04)	0.76
Q3-Q4	1.10	(1.05, 1.16)	<0.01
Age	1.02	(1.02, 1.02)	<0.01
Year of Treatment	1.05	(1.04, 1.06)	<0.01
Tumor Grade			
Moderate	1	Baseline	
Poor	1.17	(1.13, 1.21)	<0.01
Well Differentiated	0.82	(0.74, 0.9)	<0.01
Treatment type			
Prostatectomy	1	Baseline	
External Beam Radiation	1	Baseline	
Radio implants	0.47	(0.45, 0.5)	<0.01

Table 8. Cox Proportional Hazard model including income, percent completing high school, age, year of treatment, tumor grade, and treatment type, *without race.*

Clinical and Demographic Characteristics	Percent change		
	Est	95% CI	P value
Median Income			
Q0-Q1	1	Baseline	
Q1-Q2	0.95	(0.91, 1)	0.03
Q2-Q3	0.92	(0.88, 0.97)	<0.01
Q3-Q4	0.93	(0.88, 0.98)	0.01
Percent completed HS			
Q0-Q1	1	Baseline	
Q1-Q2	0.96	(0.91, 1)	0.07
Q2-Q3	1.00	(0.95, 1.05)	0.93
Q3-Q4	1.12	(1.06, 1.18)	<0.01
Age	1.02	(1.02, 1.02)	<0.01
Year of Treatment	1.05	(1.04, 1.06)	<0.01
Tumor Grade			
Moderate	1	Baseline	
Poor	1.17	(1.13, 1.21)	<0.01
Well Differentiated	0.82	(0.74, 0.9)	<0.01
Treatment type			
Prostatectomy	1	Baseline	
External Beam Radiation	0.29	(0.28, 0.3)	<0.01
Radio implants	0.48	(0.45, 0.5)	<0.01
Race			
Caucasian	1	Baseline	
Asian	1.11	(1.01, 1.21)	0.02
Black	1.05	(0.99, 1.11)	0.10
Hispanic	1.31	(1.19, 1.45)	<0.01
Other	0.89	(0.81, 0.99)	0.02

Table 9. Cox Proportional Hazard model including income, percent completing high school, age, year of treatment, tumor grade, treatment type, *with race included.*

Model interpretation:

Baseline subjects are those living in census zones below the first quartile in percentage who finished high school and below the first quartile with median income. They were white, age 65, treated in the year 2000, had a moderate tumor grade, and were surgically treated.

SES according to median income: Income level had a significant effect on time to an incontinence diagnosis, with subjects with higher incomes having a longer time until incontinence. Compared to subjects living in a census zone with a median income below the first quartile, subjects in zones with median incomes between quartiles 1 and 2 had an incontinence rate 5% lower (95% CI: 1%-9%, p = 0.03), subjects in census zones with median incomes between quartiles 2 and 3 had incontinence rates 8% lower, (95% CI: 3%-12%, p <0.01) and subjects between quartiles 3 and 4 had incontinence rates 7% lower (95% CI: 2%-12%, p = 0.01).

SES according to percent finishing high school: The percentage of people in the census zone that had finished high school had less of an impact than income levels. When compared to census zones with percentages lower than the first quartile, the only group that was significantly different were those living in zones with percentages greater than the third quartile. This group had a *higher* rate of incontinence, with an average increase of 12% (95% CI: 6%-18%, p < 0.01).

Age: An increase in age led to increases in incontinence diagnoses, with a 1.8% increase (95% CI: 1.5%-2.1%, p < 0.01) in rates for every year older a subject was (beyond age 65). This means that subjects who were 70 years old had a 9% higher rate, on average, of incontinence diagnoses when compared to 65 year old subjects.

Year of treatment: The year of treatment significantly affected the rate of incontinence diagnoses, with a 5% increase in rates (95% CI: 4%-6%, p < 0.01) for every year after 2000 that the subject was treated.

Tumor grade: Subjects with a poor tumor grade were 17% more likely to have an incontinence diagnosis (95% CI: 13%-21%, p < 0.01) than those with a moderate grade tumor. Subjects with a (95% CI: 10%-26%, p < 0.01) well-differentiated tumor were 18% less likely to have an incontinence diagnosis than those with a moderate grade tumor.

Treatment: Subjects who were surgically treated had by far the highest rates of incontinence diagnoses. Next were subjects who had radiation after surgery had diagnosis rates 21% lower (95% CI: 14%-21%, p < 0.01), followed by those who had combo treatment (45% lower, 95% CI: 42%-48%, p < 0.01), followed by those who had radio implants (52% lower, 95% CI: 50%-55%, p < 0.01). The group with the lowest rates of incontinence diagnoses were those who received external beam radiation, with rates 71% lower (95% CI 70%-72%, p < 0.01) than those who were treated with surgery only. We recognize that the treatment covariate is not randomly assigned to each subject, and is in fact determined by the severity of the prostate cancer diagnosis. Thus, in addition to representing the type of treatment, this covariate may perhaps be a proxy for disease severity.

Race: Among white, black, Hispanic and Asian subjects, white subjects had the lowest rate of incontinence diagnoses, with black subjects only slightly higher, although the difference was not significant. Asian subjects had incontinence diagnosis rates 11% higher (95% CI: 1%-21%, p = 0.02), and Hispanic subjects had rates 31% higher (95% CI: 19%-45%, p < 0.01) than white subjects.

KEY RESEARCH ACCOMPLISHMENTS:

- Hellenthal NJ, Parikh-Patel A, Bauer K, Ralph W, deVere W, Koppie TM. Men of higher socioeconomic status have improved outcomes after radical prostatectomy for localized prostate cancer. Urology. 2010 Dec;76(6):1409-13. PubMed PMID: 20888034

- Jennifer T. Anger MD, MPH, Karyn S. Eilber MD, Yolanda Hagar PhD and Theresa Koppie MD. Patterns of management of Urethral Stricture Disease after Prostate Cancer Treatment. Submitted to American Urologic Association Annual Meeting, 2013

- Karyn S. Eilber MD, Jennifer T. Anger MD, MPH, Yolanda Hagar PhD and Theresa Koppie MD. Treatment of Urinary Incontinence Varies by Type of Prostate Cancer Treatment. Submitted to American Urologic Association Annual Meeting, 2013

- Jennifer T. Anger MD, MPH, Karyn S. Eilber MD, Yolanda Hagar PhD and Theresa Koppie MD. Patterns of management of Urethral Stricture Disease after Prostate Cancer Treatment. Presented at the Society for Urodynamics, Female Pelvic Medicine, and Urogenital Reconstruction (SUFU) 2013 meeting.

- Karyn S. Eilber MD, Jennifer T. Anger MD, MPH, Yolanda Hagar PhD and Theresa Koppie MD. Treatment of Urinary Incontinence Varies by Type of Prostate Cancer Treatment. Presented at the Society for Urodynamics, Female Pelvic Medicine, and Urogenital Reconstruction (SUFU) 2013 meeting.

REPORTABLE OUTCOMES:

1. We have completed and submitted a manuscript for publication in the journal, Urology. This manuscript has been accepted for publication in upcoming months: "Men of higher socioeconomic status have improved outcomes after radical prostatectomy for localized prostate cancer" Nicholas J. Hellenthal[1], Arti Parikh-Patel[2], Katrina Bauer[2], Ralph W. deVere White[1], Theresa M. Koppie[1]

2. We have developed a SEER medicare linked database for men of medicare age who are diagnosed with prostate cancer. This database includes patient demographics, cancer staging, cancer treatment information, cancer specific survival, as well as all medicare billing during the course of their treatment.

3. An abstract has been submitted to the 2011 IMPACT meeting: PC081735, Developing an Instrument to Measure Socioeconomic Disparities in Quality of Care for Men with Early-Stage Prostate Cancer

4. Collaboration with Sergio Aguilar-Gaxiola, Director of the Center to Reduce Health Disparities at UC Davis School of Medicine on psychosocial disparities for men with erectile dysfunction after prostate cancer treatment.

5. Collaboration with Moon Chen, PhD, MPH, Associate Director for Disparities and Research at UC Davis relating to prostate cancer in Asian American men.

6. Development of a Health Disparities Conference, scheduled for February 2011, where Carmen Moten, Program Director/Health Scientist Administrator in the Disparities Training Branch, Center to Reduce Cancer Health Disparities (CRCHD) of the National Cancer Institute (NCI) will guest lecture on health disparities.

7. Collaboration with Jennifer Anger MD, MPH at Cedars Sinai/UCLA to explore interaction between socioeconomic status and post treatment urinary side effects. Currently, our analyses are moving towards our first publication.

CONCLUSION: To date, we have obtained our data and invested significant time in data cleaning and programming. We have had several publishable findings regarding the impact of SES on our initial endpoint, urinary incontinence, and are moving towards publication in this area.

PERSONNEL:

Steven McNamara, MPH

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APPENDICES:

Appendix i. ICD-9, CPT-4, and HCPCS Codes to assess outcome after prostate cancer treatment.

Appendix ii. ICD-9, CPT-4, and HCPCS Codes to quality of care for prostate cancer.

Appendix iii. Manuscript: Men of higher socioeconomic status have improved outcomes after radical prostatectomy for localized prostate cancer. Hellenthal NJ, Parikh-Patel A, Bauer K, Ralph W, deVere W, Koppie TM. Urology: 76:1409.

Appendix i.

ICD-9, CPT-4, and HCPCS Codes to assess outcome after prostate cancer treatment.

Radical prostatectomy: CPT: 55840 (Retropubic radical prostatectomy), 55842 (Prostatectomy, retropubic radical, with or without nerve sparing; with lymph node biopsy(s), 55845 (Retropubic radical prostatectomy with bilateral pelvic lymph node dissection), 55810 (Perineal radical prostatectomy), 55815 (Perineal radical prostatectomy with bilateral pelvic lymph node dissection), and 55866 (Laparoscopy, surgical prostatectomy, retropubic radical, including nerve sparing).

Diagnosis of Surgical Complications:
ICD-9: 599.1 (Urethral fistula), 596.1 (Intestinovesical Fistula), 596.2 (Vesical Fistula Nec), 596.6 (Bladder Rupt (Non Traumatic), 565.1 (Anal Fistula), 569.3 (Rectal Anal Hemorrhage), 569.83 (Perforation Of Intestine), 569.4 (Anal or Rectal Ulcer/Pain/Tear-Old/Disease), 998.1 (Hemorrhage or Hematoma complicating a procedure), 998.83 (Non-Healing Surgical Wound), 998.9 (Surgical Complication NOS), 998.2 (accidental puncture or laceration during a procedure), 998.3 (disruption of operative wound), 998.4 (Foreign Body left during procedure), 998.5 (Infected Post-Op Seroma/Other Infection), 998.6 (Persist Post-Op Fistula), 998.7 (Post-Op Foreign Substance Reaction), 604.0 (Orchitis with Abscess), E870.0 (Acc Cut/Hem in Surgery), E870.4 (Acc Cut/Hem with Scope Exam), E870.7 (Acc Cut/Hem with Enema), E870.8 (Accidental Cut in Med Care Nec), E870.9 (Accidental Cut in Med Care Nos), E871.0 (Post-Surgical Foreign Body), E873.0 (Excess Fluid in Infusion), E876.0 (Mismatch Blood-Transfusion), 956.0 (Injury to Sciatic Nerve), 956.1 (Injury to Femoral Nerve), 956.4 (Injury to cutaneous sensory nerve lower limb), 956.5 (Injury to nerve Pelvic/Leg), 956.8 (Injury to Multiple Nerves of Pelvic and Leg), 956.9 (Injury to Nerves in Pelvic/Leg Nos), 902.50 (Injury to Iliac Vessel Nos), 902.51 (Injury to Hypogastric Artery), 902.52 (Injury to Hypgastric Vein), 902.53 (Injury to Iliac Artery), 902.54 (Injury to Iliac Vein), 902.59 (Injury to Iliac Vessel Nec), 590.10 (Acute pyelonephritis without lesion of renal medullary necrosis), 590.80 (Pyelonephritis Nos), 590.9 (Kidney infection), 595 (Acute Cystitis), 595.0 (Acute Cystitis), 595.3 (Trigontitis), 595.89 (Cystitis Nec), 595.9 (Cystitis Nos), 599 (Urinary tract infection, site not specified), 599.0 (Urinary Tract Infection Nos), 599.00 (Urinary Tract Infection Nos), 599.1 (Uretheral Fistula), 599.2 (Uretheral Diverticulum), 599.7 (Hematuria), 996.31 (Malfunction of Uretheral Catheter), 996.64 (React-Indwell Urine Catheter), 996.65 (complication or infection due to urethral catheter), 998.5 (postoperative infection)

Diagnosis of GU Surgical Complications: 595.89 (Cystitis Nec), 590.1 (Acute Pyelonephritis), 590.2 (Renal/Perirenal Abscess), 590.8 (Pyelonephritis or pyonephrosis not specified as acute or chronic), 590.9 (Injection Of Kidney Nos), 591 (Hydronephrosis), 997.5 (Surgical Compl-Urinary Tract), 596.1 (Intestinovesical Fistula), 596.2 (Urethrovesical fistula), 596.6 6 (Rupture of bladder, nontraumatic), 593.3 (Stricture of kinking of ureter (postoperative), 593.4 (Ureteric Obstruction Nec), 593.5 (Hydroureter), 593.81 (Renal Vascular Disorder), 593.82 (Ureteral Fistula), 457.8 (NonInfection Lymph Disease), 567.2 (Peritonitis), 567.8 (Choleperitonitis/Sclerosing Mesenteritis/Peritonitis), 595.89 (Cystitis), 682.2 (Cellulitis of Trunk), 998.59 (Other Post-Op Infection)

Treatment of Urological Complications
CPT code: 36430 (Blood transfusion), 49000 (Exploratory laparotomy), 50392 (Percutaneous nephrostomy tube placement), 50780 (Ureteroneocystostomy), 51800 (Revision of bladder/urethra), 51860 (Cystorrhaphy, suture of bladder wound), 52332 (Insertion of ureteral stent)

Diagnosis of urinary incontinence: ICD-9: 599.82 (Intrinsic sphincter deficiency), 788.30 (incontinence of urine), 788.31 (urge incontinence),788.32 (stress incontinence, male), 788.33 (Mixed incontinence, male, female), and 788.34 (incontinence without sensory awareness).

Treatment of urinary incontinence: CPT codes: 51715 (Endoscopic injection of implant material into

the submucosal tissues of the urethra and/or bladder neck), 95028 (Intracutaneous (intradermal) tests with allergenic extracts, delayed type reaction, including reading), 53440 (Sling operation for correction of male urinary incontinence , fascia or synthetic), 57288 (Sling operation for stress incontinence, fascia or synthetic), 51992 (Laparoscopy, surgical; sling operation for stress incontinence, fascia or synthetic) 53442 (remove or revise male sling), 53444 (Insertion of tandem cuff (dual cuff)), 53445 (Insertion of inflatable urethral/bladder neck sphincter, including placement of pump, reservoir & cuff), 53446 (Removal of inflatable urethral/bladder neck sphincter, including pump, reservoir & cuff), 53447 (Removal & replacement of inflatable urethral/bladder neck sphincter, including pump, reservoir & cuff at same operative session), 53448 (Removal & replacement of inflatable urethral/bladder neck sphincter including pump, reservoir & cuff through an infected field at same operative session including irrigation and debridement of infected tissue), and 53449 (Repair of inflatable urethral/bladder neck sphincter, including pump, reservoir & cuff).

Diagnosis of Outlet Obstruction
ICD-9 diagnosis: 596.0, 596.00 (bladder neck obstruction), 599.6 (urinary obstruction), 788.2 (retention of urine), 788.21 (incomplete bladder emptying), 788.29 (other specified retention of urine), 788.38 (overflow incontinence), 788.62 (slowing of urinary stream)

Management of Outlet Obstruction
CPT code: 51701 (urethral/bladder catheterization (simple); 51010, 51040 (cystostomy), 52640, (transurethral resection of postoperative bladder neck contracture), 52276 (visual, optical internal urethrostomy), 52281 (Cystourethroscopy, with calibration and/or dilation of urethral stricture or stenosis, with or without meatotomy, with or without injection procedure for cystography, male or female), 52282 (Cystourethroscopy, with insertion of urethral stent), 52283 (Cystourethroscopy, with steroid injection into stricture), 52450 (Transurethral incision of prostate), 52500 (Transurethral resection of bladder neck (separate procedure), 52510 (Transurethral balloon dilation of the prostatic urethra, any method), 52640 (Transurethral resection; of postoperative bladder neck contracture), 53600 (Dilation of urethral stricture by passage of sound or urethral dilator, male; initial), 53601 (Dilation of urethral stricture by passage of sound or urethral dilator, male; subsequent), 53605 (Dilation of urethral stricture or vesical neck by passage of sound or urethral dilator, male, general or conduction (spinal) anesthesia), 53620 (Dilation of urethral stricture by passage of filiform and follower, male; initial), 53621 (Dilation of urethra).   ICD-9: 57.92 (Dilation of bladder neck), 58.0 (Urethrotomy), 58.1 (Urethral meatotomy), 58.31 (Endoscopic excision or destruction of lesion or tissue of urethra (includes fulguration of urethral lesion), 58.39 Other local excision or destruction of lesion or tissue of urethra (includes excision of: congenital valve of urethra, lesion of urethra, stricture of urethra, urethrectomy), 58.6 Dilation of urethra (includes dilation of urethrovesical junction; passage of sounds through urethra; removal of calculus from urethra without incision), 60.95 (Transurethral balloon dilation of prostatic urethra)

Diagnosis of proctitis: 558.1 (Gastroenteritis and colitis due to radiation)

Diagnosis of cystitis: 595.x (Cystitis), 595.82 (Irradiation cystitis).

Diagnosis of hemorrhagic cystitis: 599.71 (Gross hematuria), 595.82 (Irradiation cystitis), 596.7 (Hemorrhage Into Bladder Wall)

Diagnosis of rectal hemorrhage: (569.3) (Bleeding, rectal)

Blood transfusions: CPT code: 36430, HCPCS: P9038 (Red blood cells, irradiated, each unit), P9022 (Red blood cells, washed, each unit), P9021 (Red blood cells, each unit), P9016 (Red blood cells, leukocytes reduced, each unit), P9011 (Blood (split unit), specify amount4), P9010 (Whole blood, for transfusion, per unit), C1018 (Blood, leukoreduced, irradiated, each unit), C1016 (Blood, leukoreduced, frozen/deglycerol/washed, each unit), C1010 (Blood, leukoreduced, CMV negative, each unit), P9039 (Red blood cells, deglycerolized, each unit), C1011 (Platelet, HLA-matched leukoreduced, apheresis/pheresis,each unit), P9040 (Red blood cells, leukocytes reduced, irradiated, each unit)

Appendix ii.

ICD-9, CPT-4, and HCPCS Codes to quality of care for prostate cancer.

Pretreatment imaging: CPT Code: 74150 (CT abdomen w/o contrast), 74160 (CT abdomen w/contrast), 74170 (CT abdomen w/o & w/contrast), 78306 (Bone Scan, Whole Body)

Use of conformal radiotherapy treatment planning: CPT Code: 77295 (conformal planning), 77301 (IMRT Plan (after CT imaging)), G0178 (IMRT planning)

Use of high-energy (> 10 MV) photons: CPT Code: 77404-06, 77409-11or 77414-16

Use of custom immobilization during radiotherapy: CPT Code: 77334

Completion of two follow-up visits with radiation oncologist in first posttreatment year: CPT Code: 9921x, 9922x, 9923x, 9924x, 9925x, 9938x, 9939x

Consultation with a urologist or radiation oncologist: CPT Code: 9920x, 9924x

GnRH Agonists: HCPCS codes J9202 (Goserelin acetate implant, per 3.6 mg), J9202 (Goserelin acetate implant, per 19.8 mg), (J1950 (Injection, leuprolide acetate (for depot suspension), per 3.75 mg), J9217 (Leuprolide acetate (for depot suspension), 7.5 mg), J9218 (Leuprolide acetate, per 1 mg), J9219 (leuprolide acetate implant 65 mg)

PSA: HCPCS Codes: 84153 (Prostate Specific Antigen (PSA); total), 84154 (Prostate Specific Antigen (PSA); free)

Cystoscopy: CPT codes: 52000 (Cystoscopy), 52005 (Cystoscopy and Ureter Catheter Cystouretheroscopy, with ureteral catheterization, with or without irrigation, instillation, or ereteropyelography, exclusive of radiologic service), 52007 (Cystoscopy and biopsy cystourethroscopy, with ureteral catheterization,with or without irrigation, instillation, ork ureteropyelography, exclusive of radiologic service; with brush biopsy of ureter and/or renal pelvis), 52204 (Cystoscopy with Biopsy(s), 52250 (Cystoscopy and radiotracer, Cystourethroscopy with insertion of radioactive substance, with or without biopsy or fulguration), 52260 (Cystoscopy and treatment, Cystouretheroscopy, with dilation of bladder for interstitial cystitis; general or conduction (spinal) anesthesia), 52265 (Cystoscopy and treatment, Cystourethroscopy, with dilation of bladder for enterstitial cystitis; local anesthesia), 52270 (Cystoscopy and revise urethra, Cystourethroscopy, with internal urethrotomy; Female), 52275 (Cystoscopy and Revise Urethra, Cystourethroscopy, with internal urethrotomy; Male), 52276 (Cystoscopy and treatment, Cystourethroscopy with direct vision internal urethrtomy), 52277 (Cystoscopy and treatment, Cystourethroscopy, with resection of external sphincter (sphincterotomy), 52281 (Cystoscopy and treatment, cystourethroscopy, with calibration and/or dilation of uretheral stricture or stenosis, with or without meatotomy, with or without injection procedure for cystography; Male or Female), 52283 (Cystoscopy and treatment, Cystourethroscopy, with steroid injection into stricture), 52285 (Cystoscopy and treatment, Cystourethroscopy for treatment of the female urethral syndrome with any or all of the following: Urethreal meatotomy, Urethral Dilation,Internal Urethrotomy, Lysis of Urethrovaginal Septal ibrosis, Lateral Incisions of the bladder neck, and fulguration of polyp(s) of urethra, bladder neck, and/or trigone), 52310 (Cystoscopy and treatment, Cystourethroscopy, with removal of foreign body, calculus, or ureteral stent from urethra or bladder (separate procedure); simple.

Men of Higher Socioeconomic Status Have Improved Outcomes After Radical Prostatectomy for Localized Prostate Cancer

Nicholas J. Hellenthal, Arti Parikh-Patel, Katrina Bauer, W. Ralph, White deVere, and Theresa M. Koppie

OBJECTIVE	We sought to evaluate the impact of socioeconomic status (SES) on the likelihood of undergoing radical prostatectomy (RP) or external beam radiation therapy (XRT) and the ensuing effect on cancer-specific survival (CSS) after treatment for men with low-risk prostate cancer.
METHODS	Using the California Cancer Registry database, we identified 123,953 men diagnosed with localized, Gleason ≤ 7 prostate cancer from 1996 to 2005. Patients were separated into quintiles based on socioeconomic status and were stratified by race, age, year of diagnosis, and treatment. Logistic regression and Kaplan-Meier analyses were used to determine the likelihood of undergoing RP or XRT and cancer-specific survival.
RESULTS	In the final cohort, 39,234 patients (31.7%) and 42,431 patients (34.3%) underwent RP and XRT as initial therapy. Men of lower SES were less likely to undergo RP or XRT. Men undergoing RP in the lowest SES were twice as likely to die of prostate cancer (HR 1.99, 95% CI 1.28-3.09, $P = .002$) than men in the highest SES. This difference was even more profound when adjusted for race (HR 2.20, 95% CI 1.38-3.50, $P = .001$). Similarly, men in the lowest SES who underwent XRT were also approximately twice as likely to die of prostate cancer (HR 2.24, 95% CI 1.71-2.94, $P <.001$) than men of the highest SES, regardless of race.
CONCLUSIONS	Men of lower SES are less likely to undergo RP or XRT for the management of localized prostate cancer. After RP or XRT, men of lower SES have a decreased cancer-specific survival compared with men of higher SES. UROLOGY 76: 1409–1413, 2010. © 2010 Published by Elsevier Inc.

Prostate cancer exhibits the largest differences in incidence and survival among races and ethnicities of any cancer site.[1] Meta-analyses have shown an approximately 13% increased risk of prostate cancer–specific death in African Americans when compared with whites after adjusting for clinical predictors.[2] There are numerous theories about why the mortality rates are higher in minority groups, including differences in tumor aggressiveness and stage at diagnosis, treatment, socioeconomic factors, patient beliefs, and physician biases.[1] To date, the cause of the disparities in incidence and survival remain unknown.

Differences in the outcomes of men with prostate cancer also persist with regards to socioeconomic status (SES). In one large, community-based series, it was found that men age 65 years or older living in the lowest socioeconomic quartile were 31% more likely to die of local or regional-staged prostate cancer than those in the highest quartile.[3] This is at least partially attributed to the fact that SES, and income in particular, has been associated using watchful waiting rather than surgery or radiation in men with low-risk prostate cancer.[4]

Although there is a large amount of literature concerning the relationships of race and socioeconomic status to prostate cancer–specific treatment and survival, the roles that these factors play in cancer-specific survival after treatment have not been addressed. Using a statewide database, we primarily sought to evaluate the impact of SES on the likelihood of undergoing radical prostatectomy (RP) and the ensuing effect on cancer-specific survival (CSS) after surgery for men with low-risk (Gleason ≤ 7) localized prostate cancer. Secondarily, we determined the impact of SES on the likelihood of undergoing external beam radiotherapy (XRT) and the ensuing effect on CSS after therapy for men with low-risk localized disease.

MATERIAL AND METHODS

Subjects and Databases

We used the California Cancer Registry (CCR) database, a statewide prospective cancer registry maintained by the California Department of Health Services that captured approximately 99% of the state's population from the years 1988-2005.[5]

Table 1. Descriptive table for low-grade, localized prostate cancer cases, 1996-2005

	n	%
Year of diagnosis		
1996-98	36,403	29.4
1999-2001	41,344	33.3
2002-05	46,206	37.3
Age (years)		
18-60	28,591	23.1
61-65	21,488	17.3
66-70	25,657	20.7
71-75	23,768	19.2
76+	24,449	19.7
Race		
White	86,109	69.5
African American	10,229	8.3
Hispanic	15,200	12.3
Asian-Pacific Islander	7,098	5.7
Other/Unknown	5,317	4.3
SES		
SES1—low	14,072	11.4
SES2	20,145	16.3
SES3	25,134	20.3
SES4	28,520	23.0
SES5—high	36,082	29.1
Treatment*		
Radical prostatectomy	39,234	31.7
Radiation	42,431	34.2
Neither	42,288	34.1
Total	123,953	

* Treatment categories are mutually exclusive.

Population

All prostate cancer cases between 1996 and 2005 were identified. Patients were excluded if Gleason score on prostate biopsy was >7 or if disease was not clinically localized to the prostate at the time of diagnosis. The measure of SES used in this analysis was a composite measure previously created by Yost et al using CCR and census data.[6] Census files were linked to the CCR file based on the cases' block group of residence at the time of diagnosis. Cases that were not able to be geocoded to a street address (5.5% of cases) were randomly allocated to census blocks within their county of residence. Cases diagnosed from 1996 forward were linked to 2000 census data. Principal components analysis was then used to create a composite SES score using several census variables, including median household income, education level, proportion below 200% poverty level, and median house value. Quintiles of SES score were used in the analysis, with a value of 1 representing the lowest SES level and a value of 5 representing the highest SES level. Table 1 illustrates the demographic characteristics of the study population.

Variables

For each identified case, data regarding race, age, year of diagnosis, and treatment type were abstracted. All analyses used the American Joint Committee on Cancer (AJCC) TNM staging system related to time of diagnosis.

The CCR database classifies race as white, African American, Hispanic, Asian-Pacific Islander, or other; and treatment type as radical prostatectomy, other surgery, radiation, chemotherapy, hormone therapy, other therapy, or no therapy. We defined radical prostatectomy solely as radical prostatectomy with or without lymphadenectomy.

Statistical Analysis

Descriptive statistics were used to summarize the demographic characteristics of the study population. Bivariate analyses were conducted to examine the relationships between: (1) SES and radiation therapy and (2) SES and radical prostatectomy, stratified by the following variables: year of diagnosis, race, and age group. Mantel-Haenszel odds ratios and their 95% confidence intervals were generated. For the survival analyses, our outcome of interest was death resulting from prostate cancer; deaths from other causes were censored at the time of death. Cause of death was categorized according to the International Classification of Diseases system. Cases with ICD-9 cause of death code 185 and those with ICD-10 cause of death code C61 were designated as having died of prostate cancer. Unadjusted survival curves by SES were produced using the Kaplan-Meier method. Cox proportional hazards models were generated to examine the effect of SES on survival from prostate cancer. Two separate models were produced, one for patients who received radiation therapy and another for those who underwent radical prostatectomy. The models were adjusted for age and race/ethnicity. Log-log plots were used to test the proportionality assumption of the model. No violations of this assumption were found upon examination of these plots. SAS 9.1 software was used for all analyses (SAS Institute, Inc., Cary, NC).

RESULTS

Between January 1996 and December 2005, we identified 39,234 patients (31.7% of total) who underwent radical prostatectomy (RP) as initial therapy for clinically localized, Gleason ≤7 prostate cancer (Table 1). Over the same time frame, we identified 42,431 men (34.2%) who underwent XRT as initial therapy for the same disease. Patients in the study ranged in age from 34-104 years (mean, 67 years), and median follow-up was 53 months (range, 0-119). Five-hundred seventy-three men (0.5%) died of prostate cancer in the radiation group, and 210 patients (0.2%) died of prostate cancer in the RP group. Median survival was 51 and 64 months in those who received RP and XRT, respectively.

Men of lower SES who underwent RP had a higher odds of cancer-specific death over the time frame studied (Table 2A). In fact, men of the lowest socioeconomic status were 2.0 times more likely to die of prostate cancer than their counterparts in the highest SES after RP (95% CI 1.28-3.09, P = .002). When adjusted for race, the differences were even more disparate as patients in the lowest SES were 2.20 times more likely to die of prostate cancer than the highest SES (95% CI 1.38-3.50, P = .001). These results are displayed graphically in Fig. 1.

Similarly, men of lower SES who underwent XRT had a significantly higher risk of prostate cancer–specific death (Table 2B). Men of the lowest socioeconomic status were 2.24 times more likely to die of prostate cancer than those in the highest SES after radiation (95% CI 1.71-2.94, P <.001). The differences were comparable when adjusted for race, with those of the lowest SES being 2.21 times more likely to die of prostate cancer (95% CI 1.66-2.95, P <.001). These results are displayed graphically in Fig. 2.

Table 2. Prostate cancer–specific survival in **(A)** patients undergoing radical prostatectomy and **(B)** patients receiving XRT for low-grade, localized prostate cancer

| Quintile of SES	Percent of Patients	Unadjusted HR (95% CI)	P Value	Race* and Age Adjusted HR (95% CI)	P Value
A.					
SES1	9.7	1.99 (1.28-3.09)	**.002**	2.20 (1.38-3.50)	**.001**
SES2	15.0	1.53 (1.01-2.31)	**.042**	1.57 (1.04-2.39)	**.034**
SES3	19.3	1.49 (1.01-2.19)	**.045**	1.49 (1.01-2.20)	**.045**
SES4	23.5	0.94 (0.62-1.42)	.757	0.93 (0.61-1.41)	.732
SES5	32.5	Reference 1.0		Reference 1.0	
B.					
SES1	10.0	2.24 (1.71-2.94)	**<.001**	2.21 (1.66-2.95)	**<.001**
SES2	15.6	1.57 (1.22-2.04)	**<.001**	1.50 (1.15-1.96)	**.003**
SES3	20.7	1.60 (1.26-2.03)	**<.001**	1.55 (1.22-1.97)	**<.001**
SES4	23.6	1.13 (0.88-1.45)	.335	1.12 (0.87-1.44)	.371
SES5	30.1	Reference 1.0		Reference 1.0	

Hazard ratios are listed with associated *P* values. Statistically significant values are bold. Statistical significance was achieved when the 95% CI did not cross 1.0.
* Excludes race other than non-Hispanic white, non-Hispanic black, Hispanic, Asian-Pacific Islander.
  (Source, California Cancer Registry http://www.ccrcal.org). California Dep Publ Healthc Cancer Surveill Res Branch, April;2008:1988, released April 2008.
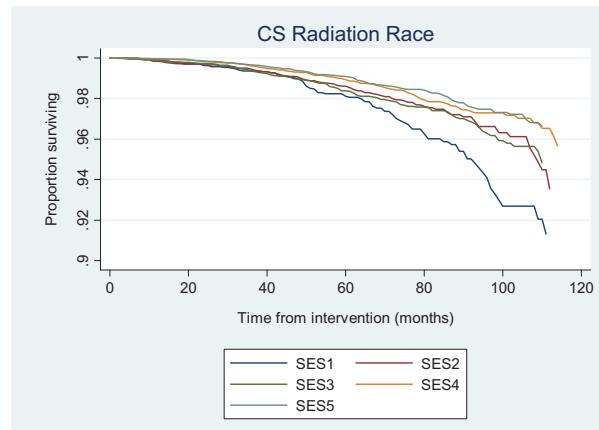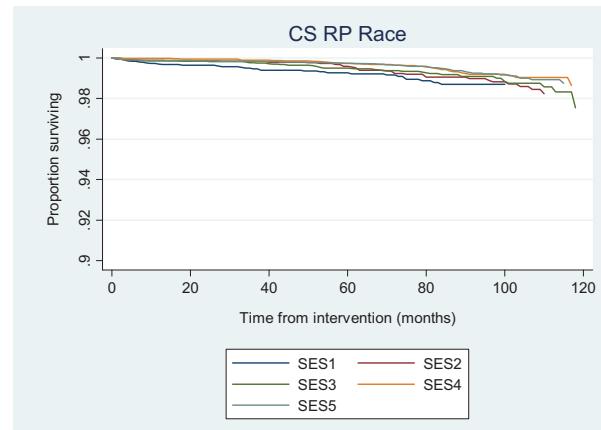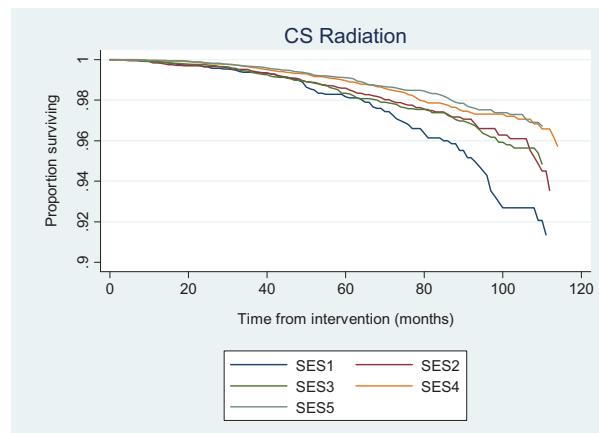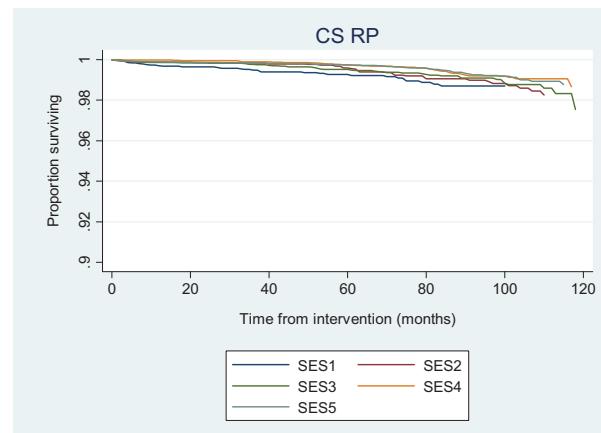
Figure 1. Cancer-specific survival in patients undergoing RP for low-grade, localized prostate cancer: **(A)** unadjusted and **(B)** adjusted for race.

Figure 2. Cancer-specific survival in patients receiving XRT for low-grade, localized prostate cancer: **(A)** unadjusted and **(B)** adjusted for race.

The effects of SES on treatment with XRT or RP remained despite year of diagnosis (and treatment), race, and age at diagnosis (not shown). In general, men of lower SES were less likely to receive prostatectomy or XRT regardless of year of diagnosis, race, and 5-year age group over 60 years. Men in the lowest SES were roughly 40% less likely to undergo prostatectomy and 30% less likely to receive radiation than those in the highest SES for each breakdown in year of diagnosis, age, and race (not shown).

COMMENT

Prostate cancer is a disease that exhibits profound racial and social disparities in regards to incidence, treatment, and outcome.[7] Prior studies have documented differences of approximately 13% in prostate cancer–specific survival, favoring whites over African Americans, although other studies have demonstrated that racial difference in survival was completely eliminated after further adjustment for tumor grade, socioeconomic status, and year of diagnosis.[7] We sought to examine the relationship between SES and treatment administered as well as prostate cancer–specific survival after definitive treatment (XRT or RP) in patients with low-risk prostate cancer.

Our results show that men of lower SES are half as likely to undergo radical prostatectomy for low-risk disease than those of higher SES. When adjusted for race, the difference was even more profound. This is despite the fact that men of lower SES have been found to be much more likely to be diagnosed with localized prostate cancer.[8] The reasoning behind this is likely multifactorial. Income level has been shown to be an independent predictor of prostatectomy, with lower income patients demonstrating a decreased likelihood of choosing surgery.[4] The disparity in treatment may be a result of patient-driven factors, such as work-related or financial stressors, and poor access to centers that offer prostatectomy.[9] This may also be due to physician factors, namely financial or other disincentives to offer prostatectomy to patients of lower SES. Finally, comorbidities may play a large factor in treatment selection, both for patients and physicians.

Racial disparities in surgical care have not been limited to prostate cancer. Studies have demonstrated that disparities exist in the treatment of esophageal and cervical cancers, with African Americans being less likely to undergo appropriate surgical intervention than their white counterparts.[10] This may be caused in part by health care access, but distrust in the health care system, and surgical intervention in particular, also likely plays a role.[11]

Despite treatment choice, we also found that men of lower SES who underwent either RP or radiation treatment for low-risk prostate cancer were approximately twice as likely to die of prostate cancer than their higher SES counterparts. Although the absolute numbers of men dying of low-risk disease were low, the differences attributed to SES were significant. Patients generally do well after definitive local treatment for low-risk prostate cancer; however disease-free outcome has been linked to variations in technique. Studies have demonstrated that positive surgical margins, a quality-control indicator in prostatectomy, affect disease-free survival after surgery, even in low-risk disease.[12] Similarly, when it comes to definitive radiation therapy, administrative technique and dosimetry, both independent quality indicators, are known to predict biochemical failure and the likelihood of developing distant metastases.[13,14]

The differences with regards to cancer-specific survival among the higher and lower SES quartiles after definitive therapy may also be a result of clinical factors not detected in the CCR dataset. These variables include initial prostate-specific antigen and biopsy tumor burden, neither of which were incorporated into the dataset used. The slight survival differences may also be attributable to variations in the initial treatments or techniques available to patients of lower SES. Finally, another potential factor lies in the fact that men of higher SES may receive more thorough post-treatment surveillance than men of lower SES.

This study does have limitations. As previously mentioned, the CCR database does not include information on surgical margin status or dosimetry and technique of radiation administered—key components of disease-free survival. There is also no data regarding PSA status or initial tumor volume in the CCR dataset. Thus, some of the patients may not have truly been "low-risk" by strict criteria. Comorbidites are also not accounted for, because these may play into treatment choices and post-treatment outcomes. Finally, as with any large database analysis, there exists the possibility of data entry miscoding. This potential error, however, should be nonselective over the cohort analyzed, and in effect, cancel out any overt bias.

This study has demonstrated that, in the setting of low-risk disease, men of lower SES are less likely to have definitive local therapy. Moreover, men of lower SES have decreased disease-specific survival even when treated definitively for low-risk prostate cancer. These findings point to the need for improvement in prostate cancer screening and treatment for men of lower SES.

CONCLUSIONS

Men of lower SES are less likely to undergo RP or XRT for the management of localized prostate cancer. After RP or XRT, men of lower SES experience a decreased cancer-specific survival compared with men of higher SES.

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